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Analysis of Ultra Graphite Implemented Brown Soil of Cauvery Delta Zone

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ABSTRACT

Cation Exchange Capacity (CEC) of ultra-graphite (Graphite Powder, Fixed Carbon (%) > 98.0, Particle Size (d50) (µm) 3.0 ±1.5) added Brown soil changes with physical and chemical and physico-chemical properties of soil and measuring the CEC values using Cohex method. The chemical properties of Brown soil such as CEC, pH, EC and soil Basic Exchangeable Cat ions (BEC) such as Ca, Mg, Na, K and physico chemical properties such as Soil Organic Matter (SOM), Soil Organic Carbon (SOC) and physical properties such as Bulk density (BD), Porosity, Particle density (PD) using hexamine cobalt tri chloride (Cohex) as a reagent of a Brown Soil with and without addition of ultra-graphite are estimated. The physical and chemical and physic-chemical properties of Brown soil sample are correlated using statistical SPSS Pearson Correlation analysis. The CEC of ultra-graphite added brown soil sample is compared with CEC of Polymer and Vermi compost added brown soil sample are analysed using GIS mapping system. The study was carried out on Tanjore District, Madhukkur, Cauvery Delta zone, Tamilnadu, India.

KEY WORDS: Physico-Chemical, Soil, Ultra-Graphite, Cauvery Delta.

1. INTRODUCTION

The "ideal" soil would grab plenty air and water for plants to drag together and store in sufficient pore space for easy root penetration. Soil organic matter (SOM) plays a vital role in nutrient cycling and can support to develop the soil structure. Cation Exchange Capacity (CEC) of the soil influences nutrient exchange capacity, nutrient assent and constancy, which in turn influence Water Holding Capacity (WHC) and aeration. Soil bulk density (SBD) is basic soil properties manipulated greatly by the quantity of organic matter in soils, ingredient minerals and porosity. Many researchers obtained the correlation between SBD and SOM contents of soil samples and obtained a strong relationship between them. Soil CEC influences many soil's inherent fertility such as physical properties, plant nutrients, water-holding capacity, etc. More nutrients can be absorbed by a clay particle than by sand or silt particles, because the clay particle provides much greater surface area for adsorption. The air in the pore spaces (Aeration) of a well-structured, drained soil is composed of about 20% oxygen by volume; this is similar to the amount of oxygen 20.5% in the atmosphere. Soil CEC is the total of the Basic Exchangeable Cations (BEC) that a soil can hold and the exchange sites are either pH-dependent or permanent depending on the nature of soil. Electrical conductivity (EC) is a measurement that correlates with soil properties that affects properties such as crop productivity.

The Hexamine Cobalt Tri chloride (Cohex) with its simple octahedral structure offers accurate results with tiny reagent excess though it is fairly large (its ionic radius is 0.323nm according to Morel (1957). The possibility of accurate measurements of CEC is obtained with Cohex. The CEC value obtained from Cohex method is highly dependable, precise and this method is quite practicable and it possesses good reproducibility (Ciesielski, 1997).

Elemental carbon is presents in two natural allotropes, diamond and graphite. Diamond is among the hardest materials, while graphite is soft enough to form a blotch on paper. All carbon allotropes are solids under typical conditions with graphite being the most thermodynamically stable form which, increase in SOC may be resulted in the upgrading of global economic condition. Ultra graphite increase crop yield all the way through better seed planting. The Ultra graphite is also added to lubricate the mechanical parts of the planter exposed to the seeds. Depending on the composition of the ultra-graphite, that is the graphite powder content, the better lubrication and less wear from the ash content can be premeditated. Based on these studies, it is intended to study the variation in the Soil Organic Carbon (SOC) that may lead to change in CEC of soil samples and the relationship can be established more precisely with the study by adding ultra-graphite (Mohamed, 2015).

2. MATERIALS AND METHODS

Study Region (Brown Soil): Tanjore (Madhukkur -Tamilnadu, India) is located at Cauvery Delta Zone and its elevation of about 59 meters. It lies between 10º 08' of Northern latitude and 78º 48' of Eastern longitude. The mean temperatures vary between 32° C and 23° C respectively. The highest temperature ever recorded is 35° C and the lowest is 24°C. The district gets 934 mm rainfall in a year. Tanjore receives 328 mm rainfall from South West monsoon (June-Sep.) followed by a high rain fall of 463 mm from North East Monsoon (Oct-Dec.).

A brown soil sample of about 2 Kg was taken and dried in air for an hour. To the brown soil sample of about 2 Kg, was added ultra-graphite (15% w/w) and performed analysis. The samples were analyzed for physical and physico-chemical and chemical properties using standard procedures. The Basic Exchangeable Cation (BEC) concentrations of brown soil sample are represented in Table 1. The pH and electrical conductivity of soil samples (before and after the addition of graphite powder) were determined in 1**:** 2.5 ratio of soil and water suspension. SOM was estimated from SOC using the conventional relation, SOM = SOC X 1.52.

BECs like Calcium, Magnesium and CEC of brown soil before and after the addition of graphite powder were calculated by Cohex method. The CEC was calculated using the relation, CEC ($Cmol^+/Kg$) = Exchangeable ($Ca^{++}+Mg^{++}+Na^{+}+K^{+}$) x Factor Value (1.20).

For organic carbon Walkley Block method was applied, and for the other soil physical properties such as bulk density, porosity, water holding capacity, particle density of brown soil, the Keen-Rackzowski box was employed. BECs such as Sodium and Potassium were estimated by using Flame photometer.

3. RESULTS AND DISCUSSION

FT-IR Analysis of Ultra Graphite added Brown Soil: To substantiate the presence of Graphite along with Cohex in the soil, FT-IR studies were employed. Though physically added the graphite powder may be lost by any effect with soil entities before estimations were made. Fundamental vibrations of organic molecules arise in IR region and could be studied in the FT-IR spectra. Overtones and combination bands in FT-IR due to organic matter result from the stretching of various functional groups such as N-H (3422 cm^{-1}) (Ben Dor, 1995; Goddu,1960).

The addition of ultra-graphite along with Cohex to the soil was avowed by FT-IR analysis which is presented in Figure 1. The band at 1647 cm^{-1} indicates the presence of N-H bending of amines and band at 1027 cm^{-1} represents C–N of aliphatic amines which strongly confirms the presence of amine of Cohex compound. Also, the weak band at 714 cm^{-1} may be due to C-C bending which supports the presence of graphite in the soil sample.

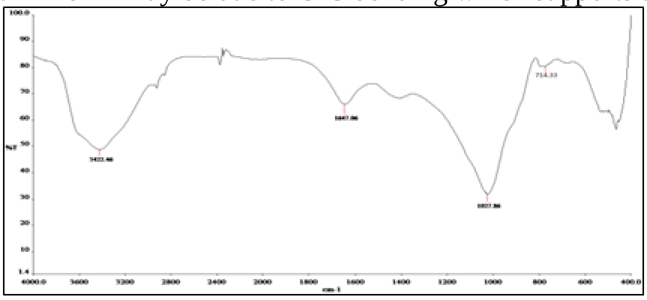

Fig.1. FT-IR spectrum of Brown soil after the addition of ultra-graphite

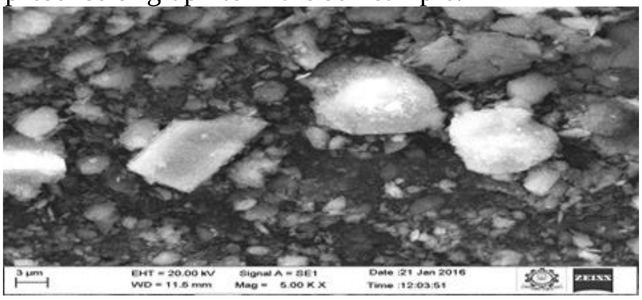

Fig.2. SEM Analysis of ultra-graphite added Brown Soil

Table.1. FT-IR spectrum of Brown soil after the addition of graphite powder

S.No	Wave Number (cm^{-1})	Bond Type	Functional Group (cm^{-1})
1	3422	N-H (Stretch)	amines
2	2087	C≡C	alkynes
3	1647	N-H (Bend)	amines
4	1027	C-N (Stretch)	aliphatic amines

The image taken with a scanning electron microscope (SEM) in Fig.2, indicates that the mean diameter of the Ultra graphite powder is about 3μm. SEM image of Brown soil clearly exhibited that it has more of micro particles and macrospores, which directly responsible for low water holding capacity and aeration nature, but at the same time ultra-graphite (graphite powder) mixed Brown soil SEM image showed smaller particle size and more number of micropores which are responsible for the increase in water holding capacity and aeration.

Effect of Ultra Graphite on Chemical Properties of Brown soil: As the ultra-graphite is added to brown Soil with different proportions (25% to 50%), the CEC of the soil sample was found increasing from 27.3 $Cmol^+/kg$ to 30.2 $Cmol^+/kg$. Generally, the inherent fertility, and long-term productivity of a soil is greatly influenced by its CEC. The increase in CEC suggests that soil is better managed for crop production and environmental protection by graphite addition.

For example, a soil with a low CEC (less than 5 $Cmol^+/kg$) generally has low organic matter content and hence, has a low water holding capacity. Soils with CEC greater than 20 may have moderate to high organic matter content, high water holding capacity. The more negatively charged sites in the soil (i.e., the high the CEC), the soil can hold more cations due to the presence of ultra-graphite. A soil with a high CEC has the potential to be very fertile, i.e., to have a great reservoir of nutrient cations. As the soil pH is reported to influence the soil CEC (Oorts 2003), the pH of the brown soil changes from 7.96 to 8.01 in our present study, upon the addition of graphite. Electrical Conductivity (EC) of soil sample is found reduced from 0.32 mS/cm to 0.30 mS/cm.

The Soil Organic Matter (SOM) of Brown soil sample was 0.68 mg/l, which increased to 0.80 mg/l with the influence of Ultra graphite. It has been known that graphite powder addition on soil influences the stabilization of organic carbon. Thus it was observed that Soil Organic Carbon (SOC) was increased from 0.34 mg/l to 0.40 mg/l. It was noted that CEC was closely correlated with SOC concentrations in black soil treatments which is in agreement with the study reported by Thompson (1989). In addition, a strong correlation between Soil Organic Matter (SOM) content and bulk density (BD) of soil samples were in agreement with the result of others (Leinweber, 1993; Sakin, 2011, Curtis, 1964). The Basic Exchangeable Cations (BEC) such as Ca^{++}, Mg^{++}, Na^{+} and K^{+} of graphite powder added Brown soil sample was also found Increased along with the CEC (Fig.3 and Table 2).

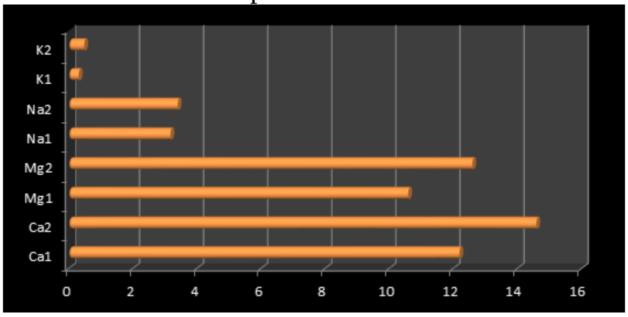

Fig. 3. Parameters viz., Ca1,Mg1,Na1,K1 are of soil with Cohex and Parameters viz., Ca2,Mg2,Na2,K2 are of soil with Cohex and graphite Parameters

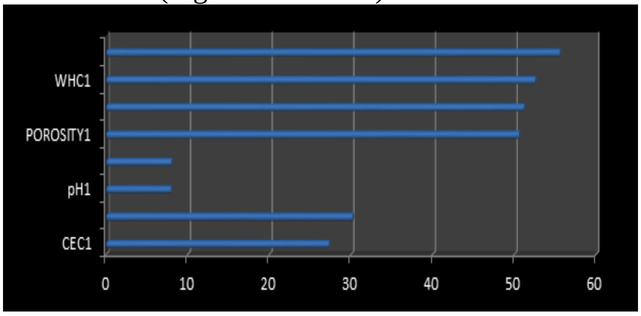

Fig.4. Parameters viz., CEC1, pH1, Porosity1, WHC1 are of soil with Cohex and Parameters., viz., CEC2, pH2, Porosity2, WHC2 are of soil with Cohex and graphite Parameters

Table.2. Basic Exchangeable Cations of without addition on brown soil and addition of ultra-graphite on brown soil

Soil type	Ca(%)	Ca_{Gra} (%)	Mg(%)	$Mg_{Gra.}$(%)	Na(%)	$Na_{Gra.}$(%)	K(%)	$K_{Gra.}$(%)
Brown	12.2	13.8	10.2	11.9	3.07	3.28	0.28	0.44
	12.5	14.1	10.5	12.52	3.13	3.37	0.30	0.47
	12.6	14.3	10.8	12.6	3.18	3.41	0.32	0.49

Effect of ultra-graphite on Physical Properties of Brown soil: SOM has a profound impact on the physical structure of soil resulting in increases of porosity, and the porosity of Brown soil sample slightly increases from 50.1% to 52.5% with the influence of Ultra graphite (Fig.3). The changes in porosity should negatively affect particle density as observed. Water holding capacity (WHC) of soil is directly governed by the Basic Exchangeable Cations (BEC) such as Ca^{++}, Mg^{++}, Na^{+} and K^{+} of Brown soil sample. The water Holding Capacity of Brown soil enhance from 52.6% to 55.6% according to ultra-graphite addition (Fig. 4). Soil Organic matter improves water holding capacity of soil samples.

The Soil Bulk Density (BD) of Brown soil sample is 1.41 g/cm^3 and the ultra-graphite is added to the Brown soil with different proportions (25% to 50%) the BD of the sample reduces to 1.32 g/cm^3. The Particle Density (PD) of the Brown soil sample was 2.14 g/cm^3 reduced to 1.85 g/ cm^3 when graphite was added soil sample. The lower particle density could account for the simultaneous reduction of bulk density (Fig.5).

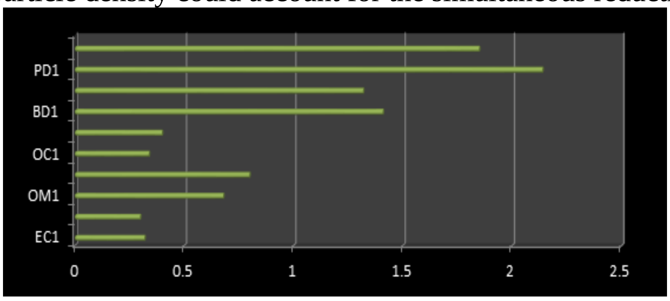

Fig.5. Parameters viz., EC1,,OM1,OC1,BD1,PD1 are of soil with Cohex and Parameters viz., EC2, OM2, OC2, BD2, PD2 are of soil with Cohex and graphite Parameters

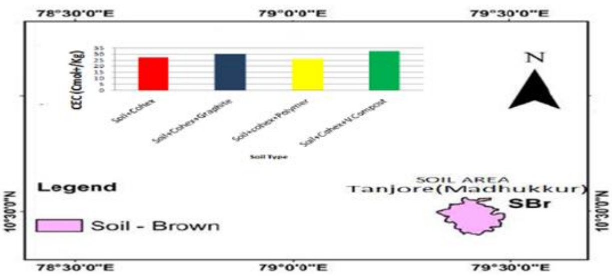

Fig.6. Comparison with Polymer (PAM) and Vermi compost added soil samples

Statistical analysis: Pearson correlation shows that the CEC of the Graphite added Brown soil samples are significant ($P \leq 0.05$) and positively correlated ($R_{Brown} = 0.974$) with SOC of soil samples and CEC also Significant and positively correlated with BEC (Table 3).

Table.3. Pearson correlation Analysis of ultra-graphite added brown soil

Soil Parameters		CEC	Ca	Mg	Na	K
CEC	Pearson Correlation	1	0.898	0.987	0.991	0.997
	Sig. (2-tailed)		0.038	0.002	0.001	0.001
	N	5	5	5	5	5

The CEC of the Graphite added Brown soil samples are significant ($P \leq 0.05$) and positively correlated ($R_{Brown} = 0.983$) with Porosity and positively correlated ($R_{Brown} = 0.993$) with WHC and the CEC of the Graphite added Brown soil samples are not significant ($P \geq 0.05$) and positively correlated ($R_{Brown} = 0.050$) with pH of soil samples. The CEC of the Graphite added Brown soil samples are significant ($P \leq 0.05$) and negatively correlated ($R_{Brown} = -0.942$) with EC of soil samples. The correlation relation shows that the CEC of the Graphite added Brown soil samples are significant ($P \leq 0.05$) and negatively correlated ($R_{Brown} = -0.937$) with BD of soil samples and CEC of the Graphite added Brown soil samples are not significant ($P \geq 0.05$) and negatively correlated ($R_{Brown} = -0.504$) with PD of soil samples.

Comparison with Polymer (PAM) and Vermi compost added soil samples: The Cation Exchange Capacity (CEC) of ultra-graphite added Brown soil sample are high compared with polymer such as polyacrylamide added Brown soil sample and CEC of Ultra graphite added Brown soil sample of is low compared with Vermi compost added soil sample as shown in Fig.6.

4. CONCLUSION

The CEC value of Brown soil sample obtained from Cohex method is highly dependable, precise and optimized and this method is relatively practicable and it acquires good repeatability and the results are reported. The CEC of Brown soil is closely correlated with SOM, SOC of soil sample. CEC of Ultra graphite added soil samples increased with increasing soil porosity, WHC and increasing the nutrients such as Ca^{++}, Mg^{++}, Na+ and K^{+} and these are very important for both the plant root and soil interface. Graphite added soil CEC‘s are negatively correlated with soil pH, EC, Bulk Density and Particle Density.

This study showed that augmented SOC under certain management systems can affect a variety of soil physical and physic-chemical and chemical properties as it is related with the addition of ultra-graphite with the Brown soil, which aids in retaining and supplying nutrients such as Ca, Mg, Na and K and also improved Water holding capacity. These upgrading studies clearly demonstrates that type of SOM plays a significant role in determining soil CEC and the suitability of occupying Cohex method for such measurements.

5. ACKNOWLEDGMENTS

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